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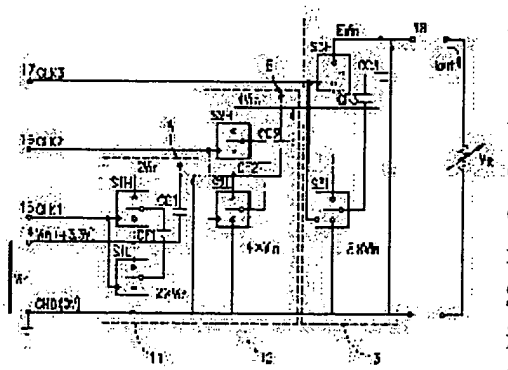
(54) POWER CIRCUIT, DISPLAY CONTAINING POWER CIRCUIT, AND ELECTRONIC EQUIPMENT CONTAINING DISPLAY



(57)Abstract:

PROBLEM TO BE SOLVED: To suppress loss in a voltage increasing circuit in an after stage which a voltage increasing circuit in a before stage suffers and enhances the voltage conversion efficiency of a power circuit, by using a different cycle for all or part of the cycles of clocks for operating respective charge pumps of voltage increasing circuits in a plurality of stages.

SOLUTION: The respective switching clock input terminals 15, 16, 17 of the voltage increasing circuits 11, 12, 13, comprising a double boosting circuit, respectively, in first, second and third stages are isolated from one another, and switching clocks CLK1, CLK2, CLK3, different in cycle, are inputted thereto.

Here, the switching clocks CLK1, CLK2, CLK3 are set so that the cycle of CLK2 is two times that of CLK1 and the cycle of CLK3 is four times that of CLK2. As a result, the voltage conversion efficiency of the entire power circuit can be enhanced.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the electronic equipment containing a display including a power supply circuit and a power supply circuit and a display.

[0002]

[Description of the Prior Art]In recent years, these days, many liquid crystal displays are further used as a display device for information displays of a Personal Digital Assistant as a display device for a display of a word processor, OA equipment called a personal computer, and the AV equipment treating a picture. This is because the liquid crystal display is provided with the feature of low power consumption by a thin light weight as compared with other display devices.

[0003]Especially the display device carried in electronic equipment which supplies electric power by a cell, such as a Personal Digital Assistant and a cellular phone, is asked for the further low power consumption. This is because most power consumption in case the electronic equipment is a waiting state, for example, the state where CPU has stopped and only the information display is performed, is what is depended on a display device, and is because the hour of use of the electronic equipment which carries it by this will be determined.

[0004]As for many of electronic equipment which makes these cells a power supply source, about [+3V] voltage is given as a power supply for display devices. Here, since about [+20V] voltage is needed for driving a liquid crystal display when a liquid crystal display is taken for an example, pressure up will be carried out to +20V from +3V in the internal electrical power source circuit of a liquid crystal display.

[0005]Conventionally, the charge pump type booster circuit using the booster circuit and capacitor which used the transformer is used as this power supply circuit.

[0006]In the method using the former transformer, only the conversion efficiency of about 60% will be acquired at the maximum, but, in the case of low current load called the liquid crystal display for Personal Digital Assistants, it will be used further in the low place of conversion efficiency. For this reason, the latter charge pump method with sufficient voltage conversion efficiency attracts attention in the state especially with little load current these days.
[0007]On the other hand, as a power supply circuit of the liquid crystal display which adopted the charge pump method, the booster circuit of international publication number WO96/21880 is known.
[0008]
[Problem(s) to be Solved by the Invention]In the booster circuit of the above-mentioned WO96/21880, since the switching clock inputted into all the pressure-up stages is the same cycle, the following problems arise.
[0009]The charge pump method is based on the double booster circuit of composition of inputting input voltage and a switching clock to two capacitors which are mentioned later, and an electric switching circuit, and the output voltage of the integral multiple of input voltage is obtained by combining this in multistage.
[0010]In the case of the above-mentioned booster circuit, 6 times as much pressure up is needed, and three steps of basic double booster circuits are piled up, and it is constituted. That is, by the 1st pressure-up stage, it increases 4 times in twice and the 2nd pressure-up stage, and pressure up is increased 6 times in the 3rd pressure-up stage. In the above-mentioned booster circuit, the switching clock of the same cycle as each pressure-up stages of all is inputted.
[0011]When it is presupposed that the voltage conversion efficiency characteristic of a charge pump booster circuit has the the same capacitor capacitance to be used, It is determined in the size of switching periods and load, when load is small (there is little load current), high conversion efficiency is shown in the place where switching periods are comparatively long, and when load is large (there is much load current), it has the characteristic that high conversion efficiency is shown in the place where switching periods are comparatively short. When a booster circuit is constituted in three steps as mentioned above, in the 1st pressure-up stage, a loss in the 2nd and 3rd pressure-up stage is also added as load besides the load current of parenchyma. Similarly, in the 2nd pressure-up stage, in order to add the loss of the 3rd pressure-up stage other than the load current of parenchyma as load, a difference arises in the size of the load current in each stage. For this reason, when the switching clock of the same cycle as these each pressure-up stage was inputted, only some pressure-up stages operated with optimum efficiency, but the problem that the conversion efficiency of the whole booster circuit will fall had them.

[0012]This invention is made that the technical problem of such conventional technology should be solved, and is a thing.
The purpose is to provide the high power supply circuit of **.

[0013]Other purposes of this invention provide the display which can attain low power consumption using the power supply circuit, and provide the electronic equipment which can attain low power consumption using the display, and can develop a hour of use (battery life).
[0014]
[Means for Solving the Problem]Are a power supply circuit which a power supply circuit of claim 1 of this invention is provided with n booster circuits (integer of n>=2) of a charge pump method, and carries out pressure up of the input power voltage by the booster circuit, and each booster circuit, Out of potential created by even booster circuit of this input power voltage and the preceding paragraph. It has composition which performs and carries out pressure up of the charge pump operation using one kind or two kinds, all or a part of cycles of a clock for performing charge pump operation of each of that booster circuit differ, and the above-mentioned purpose is attained by that.
[0015]In a power supply circuit of claim 1, a power supply circuit of claim 2 of this invention can consider a clock period of each booster circuit as composition to enlarge as it becomes the latter part.
[0016]A power supply circuit of claim 3 of this invention can be considered as composition to which only a part of pressure-up magnification with potential after pressure up enlarges a clock period in a booster circuit of potential created in a booster circuit of a certain stage, and its latter part in a power supply circuit of claim 2.
[0017]In a power supply circuit of claim 1, a power supply circuit of claim 4 of this invention each booster circuit, In the case of the first rank, it has become with composition which doubles output voltage of the preceding paragraph in the case of input power voltage or other stages, and, in the case of cycles arbitrary in the case of the first rank, or other stages, a clock period of each booster circuit can be considered as composition which becomes twice a clock period in a booster circuit of the preceding paragraph.
[0018]A display of claim 5 of this invention has the power supply circuit according to claim 1, and the above-mentioned purpose is attained by that.
[0019]Electronic equipment of claim 6 of this invention has the display according to claim 5, and the above-mentioned purpose is attained by that.
[0020]Hereafter, an operation of this invention is explained.
[0021]Are a power supply circuit which an invention indicated to claim 1 is provided with n booster circuits (integer of n>=2) of a charge pump method, and

carries out pressure up of the input power voltage by the booster circuit, and each booster circuit, Out of potential created by even booster circuit of this input power voltage and the preceding paragraph. By using all of cycles or a different cycle in part of a clock for having composition which performs and carries out pressure up of the charge pump operation using one kind or two kinds, and performing charge pump operation of each of that booster circuit, A loss in a booster circuit of the latter part which each booster circuit receives is controlled, and each booster circuit can perform operation which was suitable for load, respectively, and can raise voltage conversion efficiency of the whole power supply circuit.

[0022]An invention indicated to claim 2 is a power supply circuit of said claim 1, and can raise voltage conversion efficiency of the whole power supply circuit by enlarging a clock period of each booster circuit as it becomes the latter part.

[0023]An invention indicated to claim 3 is a power supply circuit of said claim 1, and when only a part of pressure-up magnification with potential after pressure up enlarges a clock period in a booster circuit of potential created in a certain booster circuit, and its latter part, it can raise voltage conversion efficiency of the whole power supply circuit.

[0024]An invention indicated to claim 4 is a power supply circuit of said claim 1, and each booster circuit, In the case of the first rank, in the case of input power voltage or other stages, have become output voltage of the preceding paragraph with composition to double, and a clock period of each booster circuit, By having composition which becomes twice a clock period in a booster circuit of the preceding paragraph in the case of cycles arbitrary in the case of the first rank, or other stages, voltage conversion efficiency of the whole power supply circuit can be raised.

[0025]The invention indicated to claim 5 can reduce power consumption of a display by using composition of a power supply circuit of said claim 1 for a display.

[0026]The invention indicated to claim 6 can reduce power consumption of electronic equipment by using composition of a display of said claim 5 for electronic equipment.

[0027]

[Embodiment of the Invention]Below, the embodiment of this invention is described concretely.

[0028]Drawing 1 is a block diagram showing the power supply circuit of this invention. Drawing 2 (a) shows the concrete circuitry of a switch part, and drawing 2 (b) shows the simplified schematic. Drawing 3 shows the block diagram of the double booster circuit constituted using the circuit of drawing 2.

[0029]First, the method of the pressure up of a charge pump method [as this] booster circuit twice many is explained using drawing 2 and drawing 3.
[0030]As for a coupling capacitor, D1, and D2, in drawing 2, resistance, Q1, and Q2 are FET a diode, R1, and R2 C1 and C2. When the signal inputted into a CLK terminal becomes "H", FET (Q1) turns on and the potential (VH) of the high-tension side appears in input/output terminal VI / 0. At this time, FET (Q2) is OFF. When the signal inputted into a CLK terminal is set to "L", FET (Q2) turns on and the potential (VL) of the low-tension side appears in input/output terminal VI / 0. At this time, FET (Q1) is OFF.
[0031]The double booster circuit shown in drawing 3 constituted using this circuit, With the switching clock inputted from the switching clock input terminal 32. By the high-tension-side switch part 34 which operates and the low-tension side switch part 35, the premature start capacitor 36 for pressure up further switched by those switching operation, and the capacitor 37 for an output. Pressure up is carried out to voltage twice the voltage of having been inputted into the volt input terminal 31, and it outputs from the output terminal 33.
[0032]First, when the voltage of Vin is inputted into the volt input terminal 31 and the signal of "L" is inputted into the switching clock input terminal 32, the high-tension-side switch part 34 and the low-tension side switch part 35 are connected to the terminal by the side of L. Therefore, the voltage of Vin is impressed to the premature start capacitor 36 for pressure up, and an electric charge is stored.
[0033]Next, if the signal of "H" is inputted into the switching clock input terminal 32, the high-tension-side switch part 34 and the low-tension side switch part 35 will be connected to the terminal by the side of H. At this time, the premature start capacitor 36 for pressure up and the capacitor 37 for an output are electrically connected, and the electric charge charged in previous operation by the premature start capacitor 36 for pressure up is sent to the capacitor 37 for an output. By repeating this operation, the voltage of 2xVin appears in the output terminal 33.
[0034]Based on this, the power supply circuit of this invention shown in drawing 1 is explained.
[0035]Each of the portions 11-13 surrounded with the dashed line shown in drawing 1 is the double booster circuit shown by drawing 3. The 1st step booster circuit 11 the voltage of Vin inputted into the volt input terminal 14, The high-tension-side switch part S1H and the low-tension side switch part S1L are changed with the signal inputted from the 1st step switching clock input terminal 15, and an electric charge is transmitted to capacitor CC1 for an output

from premature start capacitor CF1 for pressure up by this. By this, the voltage of 2xVin appears at an A point.

[0036]The 2nd step booster circuit 12 changes the high-tension-side switch part S2H and the low-tension side switch part S2L with the signal into which the voltage of 2xVin which appeared at the A point is inputted from the 2nd step switching clock input terminal 16, An electric charge is transmitted to capacitor CC2 for an output from premature start capacitor CF2 for pressure up by this. By this, the voltage of 4xVin appears at a B point.

[0037]The voltage of 4xVin which appeared at the B point in the 3rd step booster circuit 13, The high-tension-side switch part S3H and the low-tension side switch part S3L are changed with the signal inputted from the 3rd step switching clock input terminal 17, and an electric charge is transmitted to capacitor CC3 for an output from premature start capacitor CF3 for pressure up by this. By this, the voltage of 8xVin appears in the voltage-output terminal 18.

[0038]Thus, the power supply circuit of this invention makes each switching clock input terminal of the 1st step, the 2nd step, and the 3rd step booster circuits 11-13 become independent, It is characterized by inputting the switching clock of a cycle which is different for each terminal, and the conventional example of composition of inputting the switching clock of the same cycle as all the pressure-up stages is different.

[0039]The wave-like example inputted into the switching clock input terminal of the booster circuits 11-13 of each stage is shown in drawing 4.

[0040]CLK1 is a switching clock inputted into the 1st step booster circuit. It is a switching clock into which CLK2 is inputted into the 2nd step booster circuit, and CLK3 is inputted similarly in the 3rd step booster circuit. According to the embodiment, CLK2 was set to one 2 twice the cycle of CLK1, and CLK3 was set to one 4 times the cycle of CLK1 of this. On account of production of a circuit, although all the switching clocks synchronize, even if each timing is asynchronous, there is no problem in particular.

[0041]In order to search for the conversion efficiency of the power supply circuit of this composition, load resistance VR was connected to the circuit of drawing 1, the current Iout which flows into load was changed, and it asked for input power and output power. Here, the frequency of CLK1 was set as 3.6 kHz which is easy to create from the internal clock of a liquid crystal display.

[0042]** shows the result to drawing 5. The horizontal axis took the load current Iout (mA), and the vertical axis has taken conversion efficiency (%). The variable range of load current was carried out to from 0.06 mA to 0.2 mA supposing the liquid crystal display.

[0043]<> shows the result of having inputted CLK1 into all the switching clock input terminals, and having measured similarly as a conventional example in the

same measuring circuit to drawing 5. With the block diagram of drawing 1, CLK1 (3.6 kHz) of drawing 4 was inputted into the switching clock input terminals 15-17, and, specifically, the cycle of all the switch parts of operation was made the same.

[0044]When being based on this example of an embodiment so that I may be understood from drawing 5, in all the time base ranges, conversion efficiency is improved rather than a conventional example.

[0045]Although it has three steps of booster circuit composition in the embodiment mentioned above, this invention is applicable not only like this but two or more steps of booster circuit composition.

[0046]Although the liquid crystal display was mentioned as the example and the conversion efficiency is measured in the embodiment mentioned above as a display which has a power supply circuit, this invention can be applied to the general display of not only a liquid crystal display but other methods. This invention is applicable to electronic equipment, such as a word processor, OA equipment called a personal computer, AV equipment treating a picture, a Personal Digital Assistant, and a cellular phone, as electronic equipment which has the display.

[0047]

[Effect of the Invention]As explained in full detail above, when being based on this invention, Are a power supply circuit which is provided with n booster circuits (integer of n>=2) of a charge pump method, and carries out pressure up of the input power voltage by the booster circuit, and each booster circuit, Out of the potential created by even the booster circuit of this input power voltage and the preceding paragraph. Since all of cycles or a different cycle in part of a clock for having composition which performs and carries out pressure up of the charge pump operation using one kind or two kinds, and performing charge pump operation of each of that booster circuit is used, Each booster circuit can perform operation which was suitable for load, respectively, and can raise the voltage conversion efficiency of the whole power supply circuit. The voltage conversion efficiency of the whole power supply circuit can be raised by this.

[0048]By applying this power supply circuit to a display, low power consumption of that display can be attained, low power consumption of the electronic equipment carrying that display can be attained, and a hour of use (battery life) can be developed.

CLAIMS

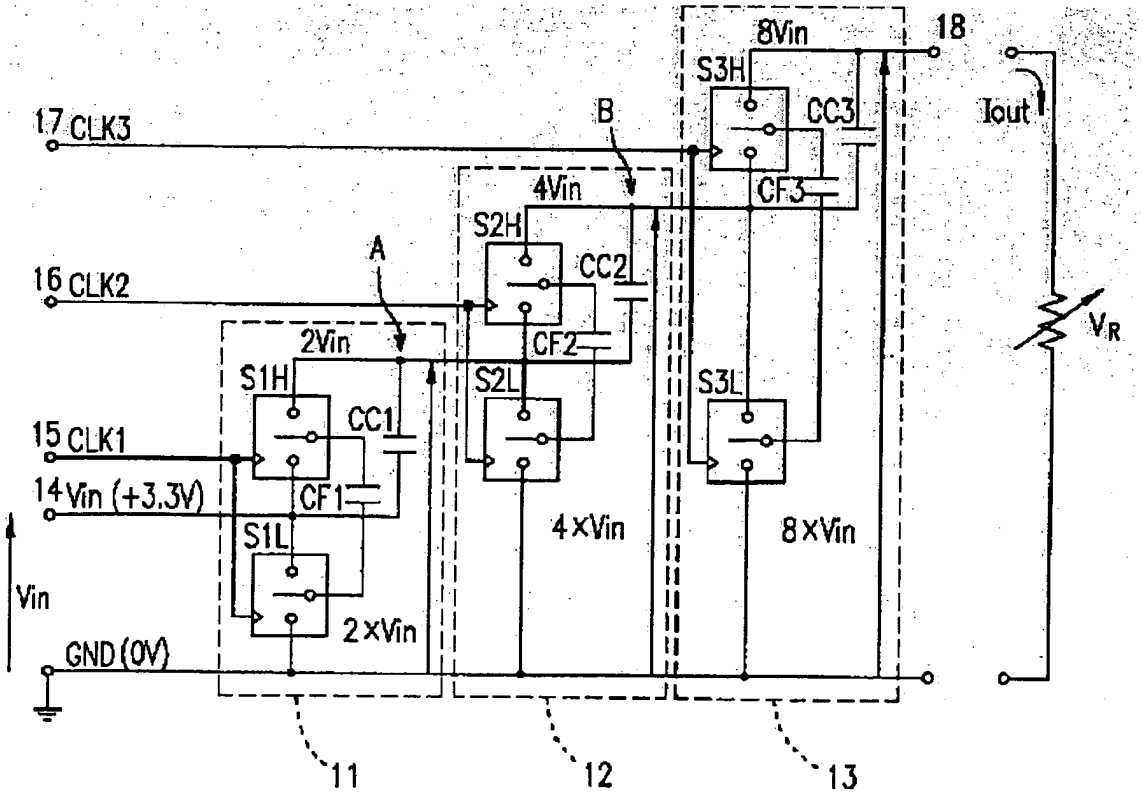
[Claim(s)]

[Claim 1]Are a power supply circuit which is provided with n booster circuits (integer of n>=2) of a charge pump method, and carries out pressure up of the input power voltage by the booster circuit, and each booster circuit, Out of potential created by even booster circuit of this input power voltage and the preceding paragraph. A power supply circuit, wherein all or a part of cycles of a clock for having composition which performs and carries out pressure up of the charge pump operation using one kind or two kinds, and performing charge pump operation of each of that booster circuit differ.
[Claim 2]The power supply circuit according to claim 1 enlarging a clock period of each booster circuit as it becomes the latter part.
[Claim 3]The power supply circuit according to claim 2, wherein only a part of pressure-up magnification with potential after pressure up enlarges a clock period in a booster circuit of potential created in a booster circuit of a certain stage, and its latter part.
[Claim 4]In the case of the first rank, in the case of input power voltage or other stages, each booster circuit has become output voltage of the preceding paragraph with composition to double, and a clock period of each booster circuit, The power supply circuit according to claim 1 which is characterized by becoming twice a clock period in a booster circuit of the preceding paragraph in the case of cycles arbitrary in the case of the first rank, or other stages.
[Claim 5]A display having the power supply circuit according to claim 1.
[Claim 6]Electronic equipment having the display according to claim 5.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a block diagram showing the composition of the power supply circuit concerning the embodiment of this invention.
[Drawing 2](a) is a circuit diagram showing the switch part of the charge pump system power circuit which applies this invention, and (b) is the simplified schematic.
[Drawing 3]It is a key map of the charge pump method [as this] booster circuit twice many applied to this invention.
[Drawing 4]It is a figure showing the example of a waveform of the switching clock inputted into each booster circuit of the embodiment of this invention.
[Drawing 5]It is a graph which compares and shows the voltage conversion efficiency of the embodiment of this invention, and a conventional example.
[Description of Notations]
11 The 1st step booster circuit
12 The 2nd step booster circuit

13 The 3rd step booster circuit
14 Power input terminal
15 The 1st step switching clock input terminal
16 The 2nd step switching clock input terminal
17 The 3rd step switching clock input terminal
18 Voltage-output terminal
CLK Switching clock
VH Potential of the high-tension side
VL Potential of the low-tension side
VI/O Input/output terminal
31 Volt input terminal
32 Switching clock input terminal
33 Output terminal
34 High-tension-side switch part
35 Low-tension side switch part
36 The premature start capacitor for pressure up
37 The capacitor for an output
CLK1 Switching clock
CLK2 Switching clock
CLK3 Switching clock



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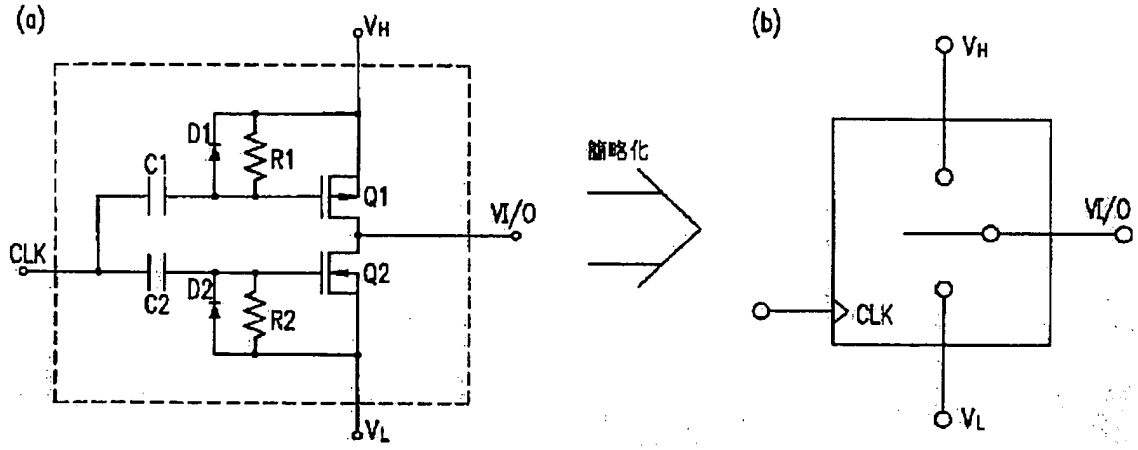
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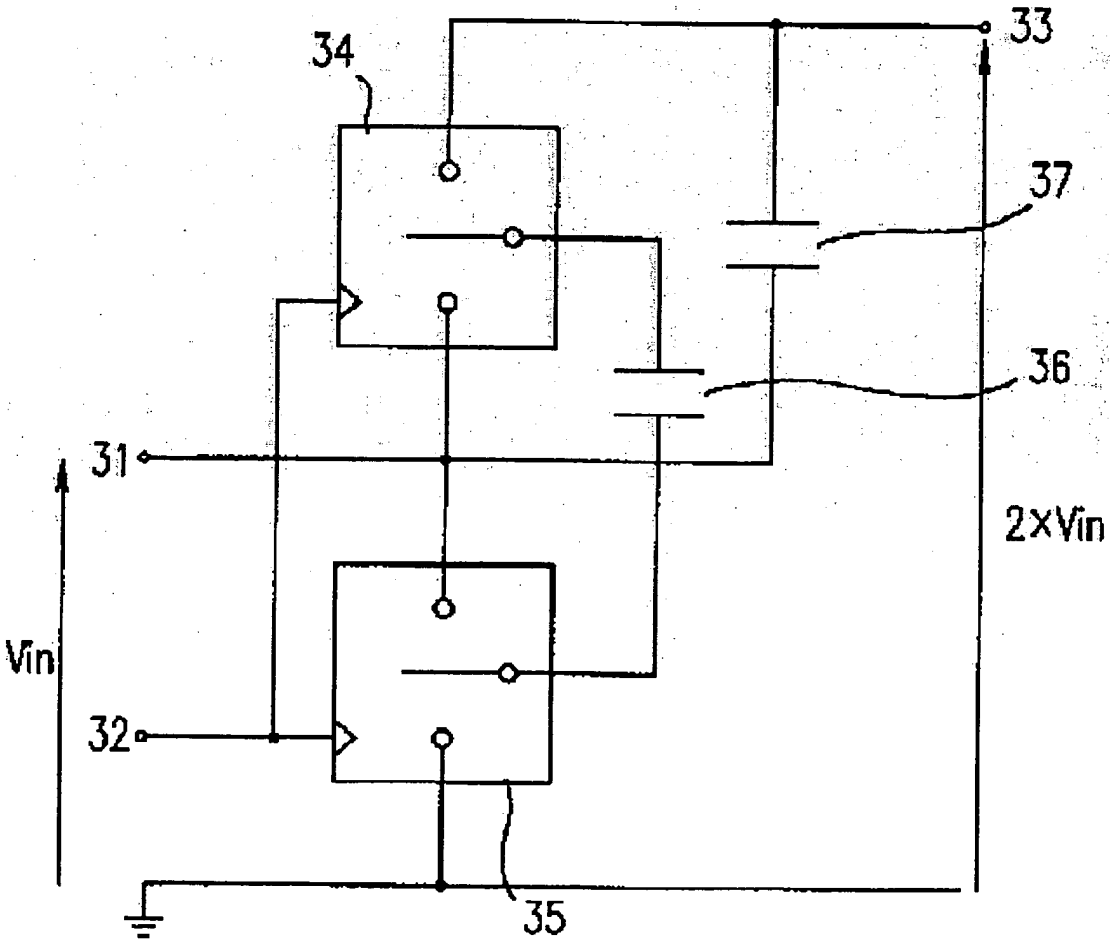
R1
C1
Q1
VI/O
CLK
C2
D2
Q2
R2
VL
簡略化
(b)
VH
VI/O
CLK
VL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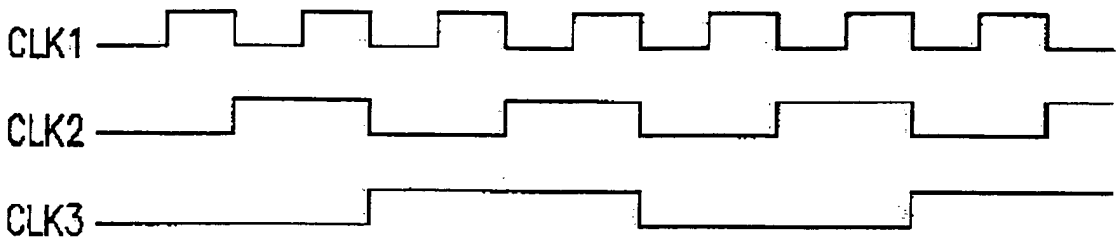
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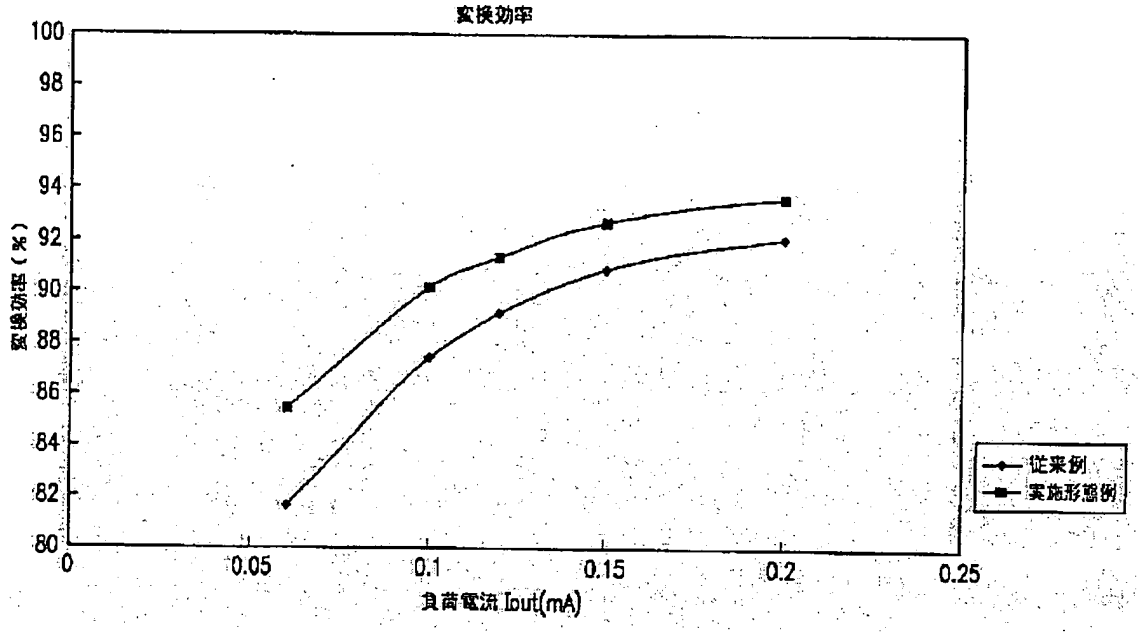
CLK2
CLK3


変換効率
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96
94
92
90
88
86
84
82
80
変換効率（%）
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0.05
0.1
0.15
0.2
0.25
負荷電流 Iout(mA)
従来例
実施形態例